Great Lakes Binational Toxics Strategy

Draft Report for

HEXACHLOROBENZENE (HCB): SOURCES AND REGULATIONS

NOVEMBER 1, 1999

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

On April 7, 1997, Canada and the United States signed the *Great Lakes Binational Toxics Strategy: Canada-United States Strategy for the Virtual Elimination of Persistent Toxic Substances in the Great Lakes* (Binational Toxics Strategy or BNS). The Binational Toxics Strategy identified twelve bioaccumulative substances having sufficient toxicity and presence in water, sediments and/or aquatic biota of the Great Lakes system to warrant concerted action to eliminate their input to the Great Lakes. They are called "Level 1 substances". Hexachlorobenzene (HCB) is one of the Level 1 substances. HCB is the subject of this report, which is in response to the "Challenge" written in the BNS:

> *Seek, by 2006, reductions in releases that are within, or have the potential to enter the Great Lakes Basin, of HCB from sources resulting from human activity.*

To guide Environment Canada (EC) and the United States Environmental Protection Agency (EPA), along with their partners, as they work toward virtual elimination of the strategy substances, the BNS outlined a four-step analytical framework:

1. Information gathering

2. Analyze current regulations, initiatives, and programs which manage or control substances

3. Identify cost-effective options to achieve further reductions

4. Implement actions to work toward the goal of virtual elimination

This report documents the analysis associated with Steps 1 and 2 of the four-step process for HCB. Step 1 encompasses identifying all sources, both within and outside the Great Lakes Basin, by economic sector, that contribute to loadings in the Basin. Step 1 also requires consideration of how the substance is used or released, its lifecycle, multi-media loadings, and associated impacts. Step 2 involves assessing existing regulations and programs and how they influence the presence of HCB in the Great Lakes Basin and long-range transport from other areas into the Basin. Both Steps 1 and 2 involve identifying gaps: information gaps as to sources, loadings, and impacts, and regulatory or programs gaps where there is opportunity to achieve greater reductions in substance releases.

Section 2 of this report discusses HCB in the environment, its impact, and effects on human health. Section 3 describes the sources of HCB and the available data sources in the Great Lakes states that characterize releases of HCB. Regulations controlling sources of HCB are outlined in Section 4, and non-regulatory programs aimed at reducing HCB releases are described in Section 5. Conclusions are provided in Section 6.

2.0 ENVIRONMENTAL AND HEALTH CONCERNS

2.1 DESCRIPTION OF HCB

Hexachlorobenzene (CAS registry number 118-74-1) belongs to a class of halogenated aromatic hydrocarbons. HCB is a white, crystalline solid that is not highly water soluble. This compound does not occur naturally. It was once used as a fungicide on the seeds of onion, sorghum, wheat, and other grains under trade names such as AntiCarie, No Bunt, and Bunt-Cure. Although there are no commercial uses of HCB in the U.S., it is formed as a byproduct in various manufacturing processes, waste streams, and combustion operations. HCB is also found as a trace byproduct or impurity in several currently used pesticides, chlorinated solvents, and other chlorinated compounds (see Section 3.0).

2.2 ENVIRONMENTAL IMPACTS AND LOADINGS

HCB is a highly persistent environmental toxin due to its chemical stability and resistance to biodegradation. In the atmosphere, HCB exists primarily in the vapor phase and degrades very slowly. HCB is partially removed from the air by wet or dry deposition, but also remains in the atmosphere and undergoes long range transport. In water, HCB partitions between the water column, suspended matter and sediment. HCB is largely bound to the suspended matter and sediment. HCB dissolved in water tends to migrate to the surface microlayer from which it volatilizes fairly rapidly. Its strong absorption characteristics may cause lengthy persistence in sediments. In soil, HCB binds strongly and generally does not leach into water. Transport to ground water is slow, but varies with the organic makeup of the soil.

HCB bioaccumulates in fish, marine animals, birds, lichens, and animals that feed on fish or lichens. In these species, HCB accumulates significantly in fatty tissues, including fat deposits and the liver, with virtually no degradation by the exposed organisms. HCB can also accumulate in wheat, grasses, vegetables and other plants. Environmental levels peaked in the 1970s and have generally declined since that time, primarily due to the cancellation of HCB as a registered pesticide.

A study of organochlorine levels in Lake Ontario lake trout showed an overall decline in HCB concentrations from 1977 to 1993 of 92% to 22.4 ng/g (Huestis at al., 1996). This level is still above the national average of 5.8 ng/g HCB detected at 46% of 400 sites across the U.S. analyzed between 1986 and 1989 as part of EPA's National Study of Chemical Residues in Fish. In that study, a maximum concentration of 913 ng/g was found in sea catfish of the Brazos River in Freeport, Texas.

2.3 EXPOSURE AND HEALTH EFFECTS

HCB release to the environment is primarily the result of industrial and agricultural activities. HCB may be emitted to air or released to waste water from facilities involved in the production of chlorinated solvents and pesticides, from fossil fuel combustion sources (e.g., flue gases or fly ash), from waste incinerators, and from the use of pyrotechnic mixtures. Wastes generated in production processes, such as aluminum plasma etching, represent another potential source of release to the environment. Non-point source releases of HCB result from its presence in several widely used pesticides. HCB releases from hazardous waste sites also contribute to environmental loadings.

Humans may be exposed to HCB in the environment through inhalation, ingestion of contaminated food, and skin contact with contaminated soil. HCB is toxic by all routes of exposure. The EPA Carcinogen Assessment Group has placed HCB on a list of substances that it considers possibly carcinogenic to humans. The International Agency for Research on Cancer (IARC) also considers the substance to be possibly carcinogenic to humans (HSDB, 1999). Short-term high exposures can lead to kidney and liver damage, central nervous system excitation and seizures, circulatory collapse, and respiratory depression. Long-term low exposures may damage a developing fetus, cause cancer, lead to kidney damage, liver damage, and fatigue, and cause skin irritation.

2.4 SENSITIVE SUBPOPULATIONS AND GEOGRAPHIC REGIONS

The general population appears to be exposed to very low concentrations of HCB. Primary exposure occurs through ingestion of contaminated food, particularly meat, dairy products, poultry, and fish. Additional, although significantly less, exposure may occur through inhalation or dermal contact.

Subpopulations who may be exposed to higher levels of HCB than the general population include workers occupationally exposed to HCB, individuals living near facilities where HCB is produced as a byproduct, and individuals living near current or former NPL hazardous waste sites where HCB is present (ATSDR, 1999). Recreational and subsistence fishermen who consume higher amounts of locally caught fish and bivalves (mussels, oysters, clams) from contaminated waters and native populations who consume caribou and other game species are additional subpopulations with potentially higher exposure. Nursing infants may also be particularly susceptible to high levels of HCB exposure.

HCB has been found in fish and wildlife throughout the U.S., but the Great Lakes has been found to be an area of particularly high contamination (ATSDR, 1999). Data collected from the National Oceanic and Atmospheric Administration's (NOAA) Mussel Watch Program show that HCB concentrations in mussels from the Great Lakes, compared to HCB levels found in mussels along marine coasts of the U.S. (East coast, West coast, Gulf coast, and marine waters), were more than five times higher in the Great Lakes. The highest HCB concentrations were found on the Niagara River at Buffalo, New York, and near Ashtabula, Ohio, in central Lake Erie (Robertson and Lauenstein, 1998). The only fish advisories for HCB listed in EPA's 1995 National Listing of Fish Consumption Advisories were for Bayou D'Inde in Louisiana and the Ashtabula River in Ohio.

3.0 SOURCES OF HCB

HCB was synthesized and used from the 1940s to the late 1970s as a fungicide, primarily on grain seeds such as wheat. HCB was voluntarily canceled for use as a pesticide in 1984 and is no longer commercially manufactured as an end product in the U.S. However, HCB is formed as a by-product, impurity, or intermediate in various manufacturing processes, including the production of chlorinated solvents and pesticides. HCB is also formed as a product of incomplete combustion in a variety of combustion and incineration processes. Control of HCB is hampered by its long range atmospheric transport from other regions.

A complete picture of HCB releases and atmospheric processes is not clear. As mandated by the 1990 Clean Air Act (CAA), Section 112(c)(6), EPA listed categories of sources accounting for not less than 90 percent of aggregate emissions of HCB in the *1990 Emissions Inventory of Section 112(c)(6) Pollutants* (EPA, 1998a). However, due to the incompleteness of data used to compile this inventory, the estimates for HCB air emissions for certain source categories are currently in question. A revised inventory of 1990 HCB emissions was prepared by EPA for a CAA Section 112(k) analysis and is expected to be included in the 1993 National Toxics Inventory (NTI) due to be released in late 1999.

Major source categories of HCB are identified in the 1990 inventory data. Additional sources of air emissions have been reported in literature studies. Some water and land releases are reported in EPA's Toxics Release Inventory (TRI). Water releases may also be identified through EPA's Permit Compliance System and waste releases through RCRA's Biennial Reporting System. Environmental monitoring studies have shown soils and sediments of lakes and rivers to be contaminated with HCB that may be recycled in the environment. HCB in land-applied sewage sludge may also cycle through the environment. Finally, sources outside the Great Lakes are thought to contribute to loadings within the Great Lakes due to long-range atmospheric transport and deposition. Sources of HCB to air, water, and waste, as well as non-point and reservoir sources, are described below.

3.1 AIR EMISSIONS

3.1.1 Sources for Which Inventory Estimates Exist

Inventory data prepared for the CAA Section 112(k) analysis and expected to be included in the 1993 NTI were obtained from EPA (Pope, 1999). Figure 1 presents national 1990 HCB emissions from these data. Total estimated HCB emissions for all source categories totaled 2.5 tons (5,000 lbs) per year.

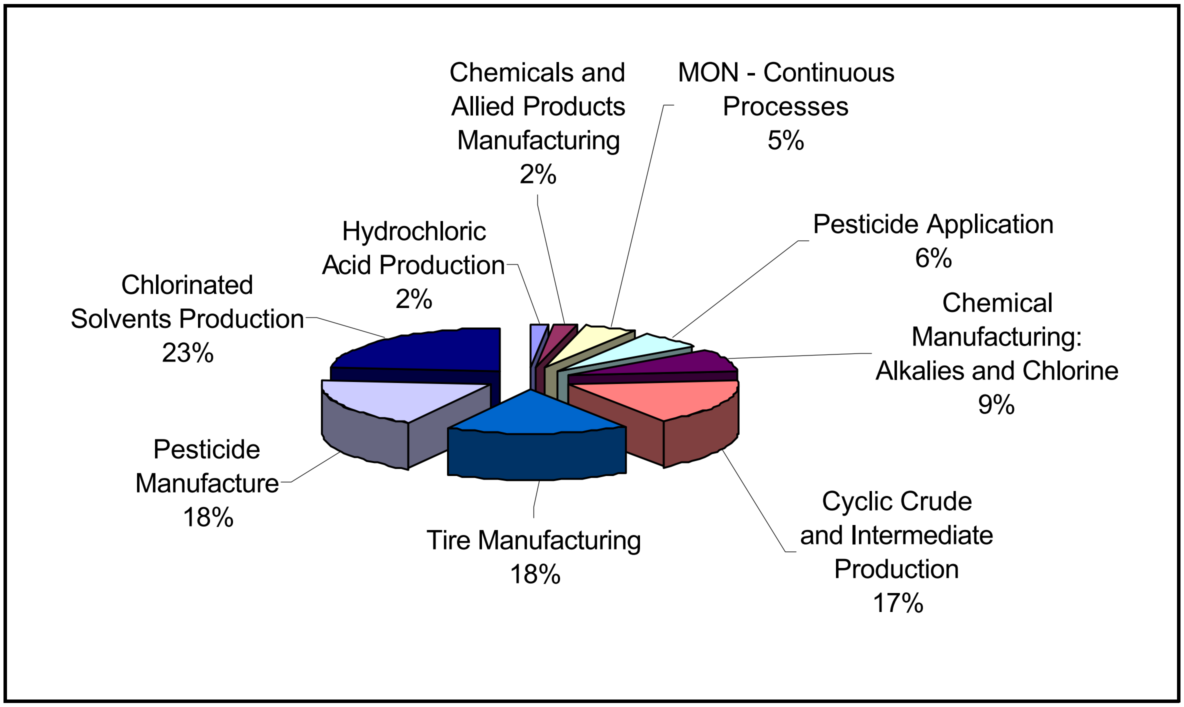

Figure 1. National 1990 HCB Emissions Estimated Using Section 112(k) Data

Chlorinated Solvents Production

EPA estimates 1990 air emissions of HCB for chlorinated solvents production at 1,162 pounds per year, or approximately 23 percent of total national HCB emissions. This source category includes the production of carbon tetrachloride, perchloroethylene, trichloroethylene, ethylene dichloride, and 1,1,1-trichloroethane. HCB is generated as an impurity during the manufacture of these chlorinated solvents, and a distillation process is used to separate HCB from the finished products. Periodically, the distillation apparatus must be cleaned, which may generate a higher than normal volume of waste.

No chlorinated solvent manufacturing facilities are located in the Great Lakes region. Long-range transport of HCB generated outside the Great Lakes region may, however, contribute to loadings within the basin.

Pesticides Manufacturing

HCB is generated as an impurity in the manufacture of chlorinated pesticides. EPA regulates the maximum allowable concentrations of HCB as a contaminant in the following pesticides: atrazine, chlorothalonil, dimethyltetrachloro-terephthalate (DCPA), lindane, pentachloronitrobenzene (PCNB), pentachlorophenol, picloram, and simazine. The national emissions estimate of HCB from pesticide manufacture is 916 pounds per year (Pope, 1999). Although HCB may be generated as a trace impurity in atrazine, simazine, and lindane, these pesticides do not commonly contain HCB (Jensen, 1999). According to information obtained from pesticide manufacturers, HCB concentrations range from 8 ppm in picloram to 22 ppm in chlorothalonil and 3000 ppm in DCPA (Benazon, 1999).

Pesticides Application

When pesticides contaminated with HCB are applied to crops, lawns, or gardens, HCB is released into the environment. Emissions from pesticide application result from volatilization of the components of the pesticide formulation. The percent of HCB that volatilizes as air emissions from contaminated pesticides has been estimated at 8%-80% (EPA, 1998; Nash and Gish, 1989; Benazon, 1999). HCB emissions from pesticides application were estimated for the 1990 national emissions inventory using a volatilization rate of 8.4%. With this volatilization rate, estimated 1990 HCB emissions are 292 pounds per year (Pope, 1999). Of this estimate, emissions of dacthal, chlorothalonil, and PCNB account for 95%, due to a combination of HCB content and annual usage. Table 1 provides information on the trade names, effect, and primary uses of pesticide active ingredients that are known to contain HCB as an impurity.

Table 1. Summary Information on Pesticide Active Ingredients Known to Contain HCB As An Impurity

Active Ingredient	Trade Names	Effect	Primary Use
Chlorothalonil	Daconil 2787, Forturf, Bravo, Exotherm Termil, Tuffcide	Fungicide	Used on most crop plants including greenhouse tomatoes and ornamentals
Dimethyl Tetrachloro-terephthalate	DCPA, Dacthal, Fatal, DAC 893, Dacthalor, Decimate	Herbicide	Used on lawns, ornamentals, onions, broccoli, cauliflower
Pentachloronitro-benzene	Terraclor, Tritisan, Quintozene, PCNB, Terraclor Super X	Soil fungicide, seed dressing agent	Used to control damping off and soil rot of cabbage, cauliflower, peanuts, peppers, beans, garlic, wheat, turf snow mold, and various ornamentals
Picloram	Tordon, Borolin, Amdon, Pin, Grazon	Systemic herbicide	Used for a wide variety of deep-rooted broadleaf weeds, in brush control along utility rights-of-way, and brush control in pasture lands

In a study of agricultural pesticide use in the Great Lakes Basin (Brody et al., 1998), chlorothalonil was found to be heavily used in the Lake Erie basin and to be among the top pesticides used in the Lake Superior basin, though total pesticide use in the Lake Superior basin is very low. Atrazine is also used in the Lake Superior basin and is widely applied in the Lake Michigan and Lake Erie basins. The regions most affected by pesticide application appear to be the western Lake Erie and southern Lake Michigan basins, primarily due to the amount of acreage used for agricultural purposes, as compared to other Great Lakes basins.

Tire Manufacturing

Estimated HCB emissions for tire manufacturing from the 1993 NTI data are 870 pounds per year. However, the Rubber Manufacturers Association (RMA), a national trade association for the rubber products industry representing all major U.S. tire manufacturers, is expected to present a report indicating that HCB is not present at detectable levels in rubber processing associated with tire manufacturing, based on tests conducted in July 1999.

In 1994 and 1995, the rubber manufacturing industry undertook a detailed study of emissions from its various processes (mixing, milling, extruding, calendaring, and curing) in an effort to help develop emission factors for the industry. The study involved testing 23 generic rubber compounds representing a range of materials processed in the rubber industry. Specific compounds used in the industry were not identified, as these are considered proprietary. HCB was detected in the mixing process in 1 of 3 samples of Compound #3, this being a rubber latex compound used as a tire belt coat. Concerns about the validity of this data point caused RMA to retest this source of HCB in rubber processing (mixing and milling), under the original 1994 testing conditions, in July of 1999. The only deviation was to improve the detection limit of the analysis by a factor of 10. EPA was directly involved in the testing, and the results will be shared with EPA when they become available.

Cyclic Crude and Intermediate Production

Manufacturing facilities in the Standard Industrial Code (SIC) code 2865, cyclic crudes and intermediates, that manufacture or process 25,000 pounds or otherwise use 10,000 pounds of HCB are required to report transfers and releases to EPA's Toxics Release Inventory (TRI) system. Reported TRI releases to air from this sector totaled 14 pounds in 1997 and came from one chemical company in Memphis, Tennessee. Smaller companies may not meet the current thresholds required for reporting to TRI. For more information regarding HCB releases reported to TRI, see Section 3.5.

Chemical Manufacturing: Alkalies and Chlorine

Manufacturing facilities in the SIC code 2812, alkalies and chlorine, that manufacture or process 25,000 pounds or otherwise use 10,000 pounds of HCB are required to report transfers and releases to EPA's Toxics Release Inventory (TRI) system. Reported TRI releases to air from this sector totaled 135 pounds in 1997 from major chemical companies. Smaller facilities may not meet the current thresholds required for reporting to TRI. For more information regarding HCB releases reported to TRI, see Section 3.5.

MON - Continuous Processes

This source category receives its title from a regulation developed under EPA's MACT program: Miscellaneous Organic NESHAP (MON). A National Emissions Standard for Hazardous Air Pollutants (NESHAP) was promulgated for miscellaneous organic chemical production or processes, which will affect approximately 150 facilities in the following source categories: benzyltrimethylammonium chloride production, carbonyl sulfide, chelating agents, ethylidene norbomene, explosives production, hydrazine, photographic chemicals, rubber chemicals, symmetrical tetrachloropyridine, paints and adhesives, and miscellaneous organic chemical. These processes are distinguished from those in the Synthetic Organic Chemical Manufacturing Industry (SOCMI), which are covered under a separate regulation.

Chemicals and Allied Products Manufacturing

Data for the 1993 NTI for this source category were extracted from TRI for SIC codes 2800 and 5161. A current search of TRI data for SIC codes 2800 and 5161 results in HCB releases being reported only under SIC code 2812 (Chemical Manufacturing: Alkalies and Chlorine), which is a subcode under 2800. It is assumed that manufacturing facilities formerly included in SIC codes 2800 and 5161 are now categorized under SIC code 2812. Chemical processes other than chlor-alkali are presumed to be covered under other SIC codes.

Hydrochloric Acid Production

This source category is comprised of about 44 companies operating 82 plants in the U.S. Over 90% of the hydrochloric acid (HCl) produced in the U.S. is produced as a byproduct in the manufacture of chlorinated organic chemicals such as vinyl chloride. The HCl is typically used captively in these processes. Most of the remaining HCl is produced via direct synthesis from the burning of hydrogen and chlorine gases. Many of these direct synthesis production units are co-located at chlor-alkali plants, where excess chlorine gas is produced. Other manufacturing processes include incineration of chlorinated organic waste gases, reaction of sulfuric acid with metal chlorides, and fumed silica production. HCl gas is typically recovered as a product (hydrochloric acid) via absorption in water. Exhaust gas from HCl absorbers is typically routed through a caustic scrubber. However, it was found that some waste gas incineration facilities do not recover and/or control HCl. Emissions of HCl and/or chlorine gas are also expected from storage tanks, process equipment leaks, and process vents associated with HCl production.

3.1.2 Other Potential Sources

Although not included in the CAA Section 112(k) inventory, other potential sources of HCB emissions have been discussed in U.S. and Canadian literature and reports. These are described below.

Utility Coal Combustion

Utility coal combustion was not identified as a source category of HCB in the 1990 data used for the 1993 NTI but was reported to account for 30 percent of total national HCB emissions in EPA's *1990 Emissions Inventory of Section 112(c)(6) Pollutants* (EPA, 1998a). The method employed to obtain the emissions estimate for this report has led to considerable uncertainty regarding the potential for coal-burning utilities to emit HCB. EPA has indicated that the single highest measurement was used in calculating an emissions estimate for utility coal combustion for the Section 112(c)(6) inventory.

The Electric Power Research Institute (EPRI) believes that utility coal combustion is not a significant source of HCB. EPRI sponsored the industry study of 14 coal-fired utility plants in the U.S. and averaged the results of three tests performed at each facility (using one-half the detection limit when HCB was not detected) to conclude that HCB was not detected at any of the sites tested. Although HCB may have been detected in some of the runs, the average of three test runs at each facility was below the detection limit.

Additional evidence that utility coal combustion is not a significant source of HCB comes from the results of stack tests performed at three Ontario coal-fired utilities. HCB was not measured above the detection limit (0.02 ng/m^3) at any of the facilities tested. Until the uncertainties with EPA's inventory estimate can be resolved, HCB emissions from utility coal combustion cannot be confirmed.

Aluminum Degassing

The use of hexachloroethane (HCE) fluxing agents to degas molten aluminum in secondary aluminum operations has been reported to release HCB (Westberg et al., 1997). However, the Aluminum Association has indicated that no large secondary aluminum operations use HCE as a fluxing agent in the U.S., and none of the small secondary aluminum furnaces that reported using HCE fluxing agents are located in the Great Lakes region.

Waste Incineration and Cement Kilns

HCB emissions as a result of the incomplete decomposition of chlorinated substances have been reported for municipal waste, medical waste, hazardous waste, and sewage sludge incinerators, as well as for cement and aggregate kilns (Benazon, 1999; Cohen et al. 1995). Emissions of HCB from municipal waste combustion units, medical waste incinerators, and cement and lightweight aggregate kilns burning hazardous waste may be controlled by recent regulations requiring standards to reduce air toxics for these source categories (see Section 4.0).

Open Barrel Trash Burning

HCB was detected in an emissions characterization study undertaken by EPA to quantify emissions from the simulated burning of household waste material in barrels (EPA, 1997). An emission factor was developed for HCB in units of pounds emitted per ton of waste burned, but no estimate of emissions from open trash burning was made. Difficulties in estimating emissions include understanding how the characteristics of the waste and burning method affect HCB emissions, as well as estimating activity levels for open trash burning. Open trash burning is thought to be a common practice in many rural townships and tribal communities of the Great Lakes. It is estimated that 95 percent of some 578 tribes in the U.S. practice open burning as a means of reducing volumes of garbage (Cummings, 1999).

Wood Preservation

HCB has been identified as a pesticide contaminant is the wood preservative pentachlorophenol (also known as “penta” or “PCP”), which is used to protect utility poles, railroad ties, and roadway guardrail posts. EPA permits HCB concentrations in pentachlorophenol no greater than 75 ppm. However, a pentachlorophenol manufacturer claims the average concentration of HCB in pentachlorophenol is 40 ppm (mg/kg). Based on information provided by the Penta Council, a trade organization of American wood preservers, a typical treated 40-ft utility pole contains about 10 pounds of PCP. From this information, the concentration of HCB in a newly treated 40-ft utility pole can be calculated as about 181 mg of HCB per pole. A study commissioned by the Penta Council shows that HCB is released to the atmosphere through volatilization and, depending on the depth of penetration of the PCP, volatilization rates range from 12% to 36%. HCB in PCP-treated utility poles also has the potential to leach and contaminate the surrounding soil (WLSSD, 1998).

There are no estimates of the approximate number of PCP-treated utility poles, railroad ties, and roadway guardrail posts in use in the Great Lakes basin. Old railroad ties and utility poles may be used in alternative ways, such as to build decks and gardens and playground equipment, that may result in higher human exposure than in their original use, due to their closer proximity to human activities.

Sewage Treatment Plants

HCB in sewage sludge may volatilize during process operations or be released to surface water in the effluent. HCB may also volatilize from sewage sludge applied to land. As discussed above, HCB emissions may also result from incineration of sewage sludge. The quantity of HCB present at sewage treatment plants varies by treatment plant, depending on the type of wastewater discharge received (e.g., rural, urban, industrial) and the type of treatment conducted.

The source of HCB at sewage treatment plants may be the receiving influent, either from individual facilities discharging HCB wastes or the resuspension of contaminated sediments, or the use of HCB-contaminated ferric chloride in treatment operations (Benazon, 1999; WLSSD, 1998). Ferric chloride is a chemical used in wastewater treatment and water purification to control odor and to facilitate settling of particles in the water. Although the source of HCB contamination of ferric chloride has not been determined, it may be due to its manufacture from low-grade hydrochloric acid (HCl) leftover from other industry operations (WLSSD, 1998).

Other Emissions

The draft Inventory of HCB Emissions/Releases for Ontario reports HCB releases from iron and steel production, and from wood and biomass burning. Additional HCB sources identified by Canada in support of the development of a North American Regional Action Plan for the Sound Management of Chemicals Program include coal production, paint manufacturing, pyrotechnics and ordinance production, soap production, pulp and paper mills, and textile mills (SMOC, 1998).

3.2 WATER RELEASES

TRI reports indicate that pesticide and chlorinated solvent manufacturers periodically discharge HCB to local water bodies. In 1997, 250 pounds of HCB were reported released to water by the alkalies and chlorine sector and 26 pounds by the agricultural chemicals sector (see Section 3.5).

Wastewater treatment plants may be the recipients of HCB waste water discharged from industrial facilities. As part of the Zero Discharge Pilot Project, Western Lake Superior Sanitary District (WLSSD) in Duluth, Minnesota, is examining the contribution of HCB, and other toxic substances, to its facilities from internal and external sources.

3.3 LAND RELEASES AND HAZARDOUS WASTES

HCB is listed as a hazardous waste and is regulated under the Resource Conservation and Recovery Act (RCRA). Chlorination processes produce HCB-containing tars and wastes in chlor-alkali, chlorinated solvents, semiconductor, and pesticide manufacturing sectors. Past methods of disposal of these wastes have included landfill disposal, discharge to municipal sewage treatment plants, and incineration. If not properly managed, landfills are a potential source of HCB release to the environment. This has been most apparent in the HCB releases to the St. Clair River from the Dow Chemical Scott Road landfill in Sarnia, Ontario. In recent years, Dow has taken measures to remediate this landfill and minimize the release of contaminants. It is not known the degree to which other landfills, previously used to dispose of HCB wastes from the chlor-alkali, chlorinated solvent, or pesticide industries, may be in similar need of remediation. EPA is currently investigating the presence of several Level 1 chemicals in landfill leachate (Cummings, 1999). High-temperature incineration (around 1300 EC) with a retention time of 0.25 seconds is the recommended method of disposal for HCB because of the greater than 99% destruction efficiency (ATSDR, 1999). However, varying conditions of high-temperature incineration can also produce other toxic chlorinated compounds.

3.4 NON-POINT AND RESERVOIR SOURCES

Long Range Transport

Long range atmospheric transport and deposition of HCB contributes to local HCB contamination. The relative contribution of long-range sources varies depending on several factors. For example, Cohen et al. (1995) found that the relative contribution of different sources to the deposition of HCB in the Great Lakes was dependent upon proximity of the sources to the Great Lakes, weather patterns (i.e., the prevailing wind direction), and the level of activity of the emission source. In this study, the relative effects of pesticide applications in diverse areas were assessed. The largest source of HCB emissions from pesticide application was the Province of Ontario, followed by Texas, Michigan, Georgia, Illinois, and California. The contribution from

Ontario was due to its proximity to the Great Lakes as well as the abundant use of HCB-contaminated pesticides in this province. Contributions from states relatively distant from the Great Lakes reflected in part their high-level use of HCB-contaminated pesticides.

There is evidence that HCB is distributed globally, as supported by concentrations of HCB found in the Arctic, away from any sources of HCB, and by similar concentrations of HCB in air over regions as far apart as Norway, the Great Lakes, and Bermuda (Cohen et al., 1995). More research on long-range transport modeling of HCB is needed to gain a better understanding of the contribution from long-range transport and deposition

Soil/Sediment

EPA's 1998 report "*The Incidence and Severity of Sediment Contamination in Surface Waters of the United States*" indicates that atmospheric deposition, industrial discharges, municipal discharges, and urban sources are ongoing sources contributing to organic chemical sediment contamination. In the Great Lakes, HCB was identified as a contaminant contributing to the classification in the report of the following sites as Tier 1 or Tier 2[1]: Ashtabula-Chagrin, Buffalo-Eighteenmile, Chautauqua-Conneat, St.Clair-Detroit, Lake St.Clair, Lower Fox, Manistee, Cedar-Portage, Niagara, Oak Orchard-Twelvemile, Ottawa-Stony, Tuscarawas, and Upper Ohio. A maximum concentration of HCB in sediment samples of 32 ppm was measured in the Ashtabula-Chagrin watershed (southern Lake Erie).

Data collected at historically contaminated sites in the Great Lakes region over the last 10 to 20 years have shown decreasing concentrations of HCB. A decrease of approximately 57 percent was seen in HCB levels in suspended solids from the mouth of the Niagara River over the period 1989-1996 (Niagara River Interpretation Group, 1992-1998, as presented in Benazon, 1999). The decreasing trends in the Great Lakes are likely the result of the elimination of major sources of release in the region; however, as discussed above, non-point urban sources are ongoing sources.

Eleven sites in EPA Region 5 are currently on the EPA Superfund Program's final National Priority List (NPL) with HCB listed as a contaminant of concern for all media (http://www.epa.gov/superfund/sites/index.htm). NPL sites are the most serious hazardous waste sites in the U.S. as identified by EPA's Superfund Program for long-term federal cleanup activities. The sites containing HCB in EPA Region 5 are listed in Appendix A.

3.5 DATA SOURCES FOR THE GREAT LAKES STATES

HCB releases are reported under several different federal and state programs. Each program deals with a different set of regulatory requirements and a different subset of the

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[1] Tier 1 sites are those where associated adverse effects are probable. Tier 2 sites are those where associated adverse effects are possible, but expected infrequently.

regulated community. HCB release information is available from three federal reporting programs:

- the Toxic Chemical Release Inventory (TRI),
- RCRA Biennial Report System (BRS) data, and
- the Permit Compliance System (PCS) data for water releases.

In addition to these federal reporting programs, ambient air and precipitation monitoring is conducted at several sites in the Great Lakes Basin through the Integrated Atmospheric Deposition Network (IADN) and Environment Canada ambient air monitoring.

Information from each of these sources is summarized below and included in detail in Appendix A. Where information was available, data are shown by SIC code to illustrate the distribution of HCB releases across industrial sectors. Appendix A provides a summary of the number of facilities that report HCB releases under each of these programs. The number of facilities reporting releases varies by reporting program as a result of differing reporting requirements.

Toxic Chemical Release Inventory (TRI)

The Toxic Chemical Release Inventory (TRI) contains chemical release and transfer information from manufacturing facilities (SIC codes 20 - 39) which have ten or more employees and that manufacture or process 25,000 pounds of a listed chemical or otherwise use 10,000 pounds of a listed chemical. Electric utilities do not fall into the SIC code range covered by TRI and therefore do not report any HCB releases under this program. Table 2 shows 1997 TRI data by industrial sector for U.S. facilities reporting HCB releases. In 1997, 9 facilities reported HCB releases, up from 8 facilities that reported in 1996. The majority of HCB releases reported in 1996 and 1997 came from GB Biosciences Corporation of Houston, Texas, whose primary industrial activity is agricultural chemicals. No facilities reporting HCB releases were located in the Great Lakes Basin.

By far, the majority of releases in 1996 and 1997 were transfers off-site to locations other than publicly owned treatment works (POTWs) for disposal. The methods used to dispose of HCB-containing waste by facilities receiving these transfers are reported to include landfill/disposal surface impoundment and incineration/thermal treatment.

Table 2. 1997 HCB Releases (pounds) from Industrial Sectors Reporting to TRI

Industrial Sector	SIC Code	Air-Fugitive	Air-Stack	Underground Injection	Off-Site Transfers[1]	Releases to Water
Alkalies & Chlorine	2812	106	29	139	6	250
Agricultural Chemicals, nec	2879	5			12,032	26
Cyclic Crudes & Intermediates	2865	14				

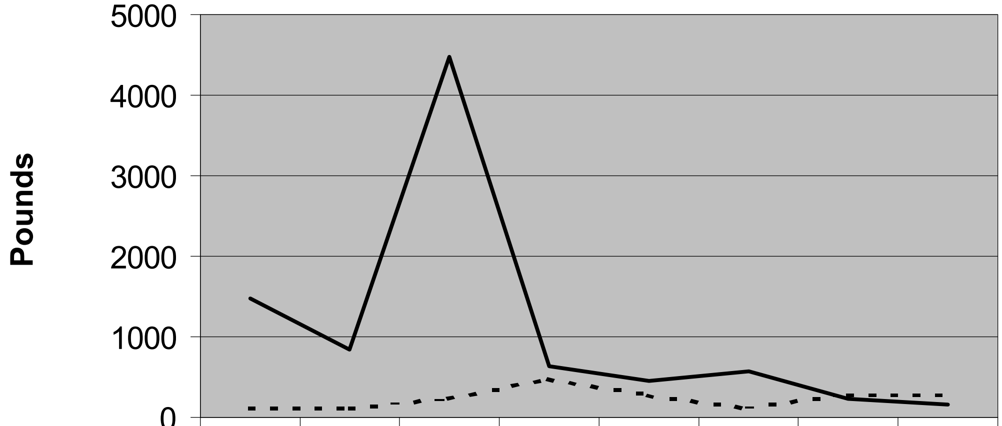
[1] Other than to publicly owned treatment works (POTWs).

Table 3 shows the trends in total HCB releases from 1990 to 1997 by industrial sector. Table A1 in Appendix A shows the trends in HCB releases reported to TRI from 1990 to 1997 by industrial sector and release category.

Table 3. Trends in Total HCB Releases (pounds) from 1990 to 1997 from TRI Data

Industrial Sector	SIC Code	1997	1996	1995	1994	1993	1992	1991	1990
Alkalies & Chlorine	2812	530	1,176	7,129	628	1,324	5,169	518	768
Agricultural Chemicals, nec	2879	12,063	23,470	7,335	940,744	648,006	28,619	1,065,057	34,091
Cyclic Crudes & Intermediates	2865	14	14	15	12	0	4	22	830
Discontinued, Changed, or Unknown	2800	—	—	—	—	—	80	209	115
Industrial Organic Chemicals, nec	2869	0	0	0	0	340	0	0	—
Cement, Hydraulic	3241	0	—	—	23	—	—	—	—

Figure 2 shows the trends in HCB air and water releases reported to TRI from 1990 to 1997 for all source categories combined.



	1990	1991	1992	1993	1994	1995	1996	1997
AIR	1468	841	4471	636	458	566	220	154
WATER	124	111	227	476	269	114	274	276

Year

Figure 2. Trends in HCB Air and Water Releases Reported to TRI from 1990 to 1997 for All Source Categories Combined

1996 National Toxics Inventory

[*Data not yet available*]

RCRA Biennial Report Data

The RCRA Biennial Report System (BRS) tracks information on hazardous waste generated and managed by large quantity generators and permitted Treatment, Storage, and Disposal (TSD) facilities. RCRA wastes containing HCB are identified by waste code “D032", which indicates that HCB is a characteristic hazardous waste in a waste stream or discarded product. HCB wastes may be also identified by other wastes codes associated with hazardous waste from specific sources. For example, waste code K016 describes heavy ends or distillation residues from the production of carbon tetrachloride. Appendix A shows the number of facilities in Great Lakes states reporting HCB-bearing waste streams to BRS. A total of 69 facilities in Great Lakes states reported HCB-bearing waste streams.

Reporting SIC code and source code are optional in BRS and are not available for all facilities. Therefore, a summary of BRS data by industrial sector and source process could not reliably be generated for facilities reporting HCB-bearing waste streams.

Permit Compliance System (PCS) Data

EPA's Permit Compliance System (PCS) data for water discharges approximates point source loads from municipal and industrial dischargers. The information is based on monitoring data supplied by regulated facilities. EPA uses PCS data as the basis for its National Pollutant Discharge Elimination System (NPDES) permit enforcement program. Table 4 presents PCS data by industrial sector for regulated facilities in EPA Region 5 issued permits between January 1, 1995 and August 31, 1999. These are facilities that were issued permits to discharge HCB. Table 4 does not imply release of HCB; data on actual discharges of HCB could not be obtained. Appendix A lists the number of facilities in Great Lakes states holding NPDES permits to discharge HCB from EPA's Permit Compliance System.

Table 4. Facilities in EPA Region 5 Issued NPDES Permits between 1995 and 1999 to Release HCB

Industrial Sector	SIC Code	Number of Permits Issued
Sewerage Systems	4952	25
Plastic Materials, Synthetic Resins, and Nonvulcanizable Elastomers	2821	10
Paper Mills	2621	6
Electric Services	4911	3
Industrial Organic Chemicals, nec	2869	3
Cyclic Crudes and Intermediates	2865	2
Other	–	11

Integrated Atmospheric Deposition Network

The Integrated Atmospheric Deposition Network (IADN) was established by the U.S. and Canada for conducting air and precipitation monitoring in the Great Lakes Basin. IADN was created as part of the 1987 amendments to the Great Lakes Water Quality Agreement through the adoption of Annex 15. Currently, the network consists of five Master Stations and 14 Satellite Stations in both Canada and the U.S. which measure wet deposition and air concentrations of gas and particulate organics and trace elements. Data comparing the wet and dry deposition, gas absorption, and gas volatilization for HCB for 1994 show that HCB appears to be volatilizing out of the lakes (IADN, 1998). Appendix A includes precipitation, particle, and gas concentration data from IADN Master Stations for HCB from 1992-1994.

Environment Canada

The Analysis and Air Quality Division of Environment Canada conducts ambient air monitoring of over 300 contaminants, including HCB, at locations around the country. In a 1997 unpublished report entitled "*Monitoring of Persistent Toxic Substances in Ontario–Great Lakes*

Basin", the median concentrations of HCB in ambient air collected at Windsor and Walpole Island showed that essentially the same levels were measured in 1987-1990 as in 1996-1997. The report also concluded that very small variability was measured between all Ontario sites and that HCB appears to have minimal local influences in Ontario but a uniform regional concentration of about 0.1 ng/m^3 (Dann, 1997).

4.0 REGULATIONS AFFECTING HCB SOURCES

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), regulates registration and use of commercially produced substances created for the purpose of pest control. FIFRA requires all pesticides sold or distributed in the U.S. (including imported pesticides) to be registered by EPA. Under FIFRA (40 CFR Subchapter E), HCB was voluntarily canceled for use as a pesticide in 1984. Cancellation of a pesticide imposes a date when sale and distribution may no longer take place (usually 18 months from the effective date of cancellation), but allows for the use of existing stocks.

Because HCB has been canceled for use as a pesticide and is not a naturally occurring compound, the major regulations currently controlling its release are those governing its generation as a byproduct in the pesticide and chlorinated solvent industries. In addition, releases of HCB are required to be reported by certain manufacturing facilities to EPA's Toxics Release Inventory System. Table 5 provides an overview of HCB regulations under the Clean Air Act (CAA), the Clean Water Act (CWA), the Safe Drinking Water Act (SDWA), the Resource Conservation and Recovery Act (RCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERLA).

Clean Air Act

In the U.S., the Clean Air Act (CAA) establishes requirements for airborne emissions from a variety of sources. USEPA, state, and regional air quality agencies are all likely to be involved in CAA implementation. Under the CAA, the major regulatory requirements include National Emissions Standards for Hazardous Air Pollutants (NESHAPS)/Maximum Achievable Control Technology (or MACT standards) for a specific list of hazardous air pollutant source categories and subcategories. Hexachlorobenzene is included on this list. The CAA also establishes the national ambient air quality standards, which although they have no direct regulatory impact, serve as baseline for judging the effectiveness of release regulations. Currently, there is no ambient air standard established under the CAA for HCB.

EPA's Air Toxics Rule for Pesticide Active Ingredient (PAI) Production promulgates national emission standards for hazardous air pollutants (HAP) as required under Section 112 of the Clean Air Act. This rule will require newly built and existing PAI manufacturing operations to reduce HAP emissions to the level corresponding to the maximum achievable control technology by using either an add-on control device or a pollution prevention (P2) alternative to control emissions from process vents. The standards regulate a variety of PAI processes, including the production of chlorothalonil and dacthal. The rule requires monitoring of HAP emissions to demonstrate compliance or submission of a Pollution Prevention Demonstration Summary, if alternate P2 options are used to meet the standards. Expected reductions in HCB emissions are not known, but HAP emissions from existing facilities are expected to be reduced by 65 percent from the baseline emission level (http://www.epa.gov/ttn/uatw/pest/fr62399s.html).

Standards of performance for equipment leaks of Volatile Organic Compounds (VOC) in the Synthetic Organic Chemical Manufacturing Industry (SOCMI) have been promulgated under 40 CFR 60.489 (7/1/97). The intended effect of these standards is to require all newly constructed, modified, and reconstructed SOCMI process units to use the best demonstrated system of continuous emission reduction for equipment leaks of VOC, considering costs, non-air-quality health and environmental impact and energy requirements. Hexachlorobenzene is produced, as an intermediate or a final product, by process units covered under this subpart. Emission standards required under the Synthetic Organic Chemical Manufacturing Industry Hazardous Organic NESHAP (SOCMI HON) (40CFR 63.100) will control emissions of organic HAP emissions from chemical manufacturing processes in the synthetic organic chemical manufacturing industry.

Table 5. HCB Regulatory Overview

CAA	CWA	SDWA	RCRA	SARA / EPCRA	CERCLA
§112(b): Designated a HAP; Major source categories identified under §112(c)(6); NESHAPS established for SOCMI (40CFR 63.100); other MACT standards to be promulgated. Air toxic rule for pesticide active ingredient production (62FR 60566)	CWA Priority: Listed priority pollutant (40CFR 423); subject to NPDES effluent limitations under §304(b) (40CFR 122) and general pretreatment (40CFR 403) Bioaccumulative Chemical of Concern (BCC) under the Great Lakes Water Quality Guidance	NPDWR / MCL: 0.001 mg/L (enforceable) MCL goal is zero	Subtitle C: HCB-containing substances are characterized as(D032) hazardous wastes - many as F & K wastes (40CFR 261.24 and 261.32); subject to hazardous waste regulations (40CFR 261.1) HCB is also listed as a Toxic Commercial Pesticide Product (U127) (40 CFR 261.33) Universal treatment standards for HCB in waste (40CFR 268.48; some F, K, and U wastes with HCB as a regulated treatment performance constituent prior to disposal can be found in CFR 268.40)	§313: Releases (by facilities with 10 or more employees and that process 25,000 lbs., or otherwise use 10,000 lbs.) must be reported to TRI (40CFR 372.65) Jan. 5, 1999 Federal Register proposed reduction of TRI reporting threshold to 10 lbs. per year (64FR 687)	§103: Spills of HCB >10 lbs. must be reported to the National Response Center

CAA: Clean Air Act
CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act
CWA: Clean Water Act
HAP: Hazardous Air Pollutant
MCL: Maximum Contaminant Level (drinking water standard)
NESHAPS: National Emissions Standards for Hazardous Air Pollutants (HAPs)
NPDES: National Pollutant Discharge Elimination System
NPDWR: National Primary Drinking Water Regulations
RCRA: Resource Conservation and Recovery Act
SARA/EPCRA: Superfund Amendment Reauthorization Act / Emergency Planning and Community Right-to-know Act
SDWA: Safe Drinking Water Act
SOCMI: Synthetic Organic Chemical Manufacturing Industry
TRI: Toxics Release Inventory

Emissions limits based on “maximum achievable control technology” (MACT) have been established for municipal waste combustion units and medical waste incinerators to address, among other pollutants, organic emissions. Similarly, regulations have been promulgated to control hazardous air pollutant emissions from incinerators, cement kilns, and lightweight aggregate kilns that burn hazardous waste. These standards will have a beneficial effect on HCB emissions from municipal and medical waste incinerators and incinerators, cement kilns, and lightweight aggregate kilns burning hazardous waste.

Clean Water Act

The Clean Water Act (CWA) regulates discharges to surface waters with the overall goal to restore and maintain the chemical, physical, and biological integrity of the nation's surface waters. To control point source discharges, the CWA established the National Pollution Discharge Elimination System (NPDES) permit program, which defines the conditions and effluent limitations under which a facility may make a discharge. The NPDES permit is the regulatory tool translating the general standards (CWA, Subchapter III) into effluent limitations and monitoring requirements applicable to specific point source polluters. Indirect discharges via municipal wastewater treatment plants or sewage treatment plants must meet pre-treatment requirements, including categorical standards developed by the EPA that apply to each industry and local standards developed by each publicly owned treatment work (POTW). Effluent guidelines regulations for both direct discharges and pre-treatment standards are generally sector specific, for example for a particular segment of industry. To address the risk of contaminated runoff, NPDES storm water permits are also required for any storm water discharge associated with industrial activity, a large or medium municipal storm sewer system, or a discharge which EPA or the State determines to contribute to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States.

Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) was established by Congress in 1974 to protect human health from contaminants in drinking water, and to prevent contamination of existing groundwater supplies. The SDWA National Primary Drinking Water Standards define enforceable maximum contaminant levels (MCLs), in addition to non-enforceable maximum contaminant level goals (MCLGs). The maximum contaminant level for HCB is 0.001 mg/L (1 ppb), and the maximum contaminant level goal is zero.

RCRA Requirements

The Resource Conservation and Recovery Act (RCRA) establishes a regulatory structure for the handling, storage, treatment, and disposal of solid and hazardous wastes. Subtitle C of RCRA addresses "cradle-to-grave" requirements for hazardous waste from the point of generation to disposal. A solid waste containing hexachlorobenzene may become characterized as a hazardous waste when subjected to testing for toxicity as stipulated in 40 CFR 261.24, and if so characterized, must be managed as a hazardous waste. As stipulated in 40 CFR 261.33, when

HCB, as a commercial chemical product or manufacturing chemical intermediate or an off-specification commercial chemical product or a manufacturing chemical intermediate, becomes a waste, it must be managed according to Federal and/or State hazardous waste regulations. Also defined as a hazardous waste is any residue, contaminated soil, water, or other debris resulting from the cleanup of a spill, into water or on dry land, of this waste. Generators of small quantities of this waste may qualify for partial exclusion from hazardous waste regulations (40 CFR 261.5).

CERCLA Reportable Quantities

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or Superfund, establishes a list of hazardous substances which are subject to release reporting regulations. Releases of CERCLA listed hazardous substances, if occurring in amounts exceeding a predefined "reportable quantity" (RQ), must immediately be reported to the National Response Center. Persons in charge of vessels or facilities are required to notify the National Response Center (NRC) immediately, when there is a release of this designated hazardous substance, in an amount equal to or greater than its reportable quantity of 10 lb (4.54 kg).

Superfund Amendment and Reauthorization Act (Emergency Planning and Community Right-to-Know Act)

The Superfund Amendment and Reauthorization Act, known as SARA Title III, or the Emergency Planning and Community Right to Know Act (EPCRA), also requires notification and reporting of hazardous substances. The key regulatory requirements of EPCRA include emergency planning and release notification, Community Right-to-Know reporting, and Toxic Release Inventory (TRI) reporting. Toxic release reporting requirements, which allow for the compilation of the national Toxic Release Inventory (TRI) database, apply to specific manufacturing facilities, which have ten or more employees, and which manufacture, process, or use specified chemicals in amounts greater than threshold quantities. Emergency planning is required when substances on the Extremely Hazardous Substances list are present in quantities exceeding the Threshold Planning Quantities (TPQs).

Principal provisions of SARA Title III that affect HCB reporting are the following. All facilities in the manufacturing sector (SIC codes 20 - 39) that manufacture or process 25,000 pounds of a listed chemical or otherwise use 10,000 pounds of a listed chemical must report air, water, and land releases to TRI. TRI thresholds are based on the quantity of each substance used, processed, manufactured, or imported at any of these facilities. Beginning with the 2000 reporting year, the threshold for reporting HCB releases to TRI is expected to be lowered to 10 pounds per year. The purpose of the proposed lowering of the reporting threshold is to capture a vast majority of sources that release HCB that are not required to report under the current reporting threshold. The proposed rule was announced January 5, 1999 (64FR687), and a final rule is expected by the end of 1999. Reporting would begin in 2000, and the first public release of data obtained through the new TRI rule would be available in 2001.

OSHA

No Occupational Safety and Health Standards exist for HCB.

Transport Methods and Regulations

No person may transport, offer, or accept a hazardous material for transportation in commerce unless that person is registered in conformance and the hazardous material is properly classed, described, packaged, marked, labeled, and in condition for shipment as required or authorized by the hazardous materials regulations (49 CFR 171.2 (7/1/96)).

State Laws

In addition to federal clean water requirements, every state also regulates water pollution within their territory. This sometimes results in a dual system of permitting, whereby each facility must obtain both a federal NPDES permit and a state discharge permit. States can gain EPA approval of the state permitting system so that the state itself administers the NPDES program. In such cases, one permit issued by the state government meets both the federal and state requirements. States have the explicit right to enact any water quality standard or limitation that is more stringent than those required by federal statute (33 U.S.C. sec.1370). Indiana, Michigan, Minnesota, New York, Ohio, and Wisconsin have set water quality standards or guidelines for HCB (ATSDR, 1999).

The states of Indiana, Michigan, New York, and Pennsylvania have set average acceptable ambient air concentrations for HCB. Illinois, Minnesota, and Pennsylvania have defined a hazardous waste toxicity characteristic for HCB. Open trash burning may be regulated by state (e.g., Michigan, Minnesota) and local laws.

5.0 CURRENT PROGRAMS FOR HCB REDUCTION

Since the toxics effects of HCB have become known, releases of HCB to the environment have been curtailed dramatically, primarily through reductions in its use as a pesticide and a pesticide by-product. More recently, HCB has become a concern regionally in the Great Lakes with the signing of the Great Lakes Water Quality Agreement and the Binational Toxics Strategy, nationally through EPA's Draft Agency-wide Multimedia Strategy for Priority Persistent, Bioaccumulative, and Toxic (PBT) Pollutants (PBT Strategy) (http://www.epa.gov/pbt/pbtstrat.htm), and internationally in global POPs negotiations. At the same time, studies are being undertaken to assess HCB loadings in the environment and to characterize human exposure. Table 6 describes these and other current domestic and international data collection and toxic reduction efforts targeting HCB.

Table 6. Current Domestic and International Efforts Targeting HCB

Current Domestic and International Efforts Targeting HCB	
Program	**Description**
National and Regional Strategies	
Binational Toxics Strategy (BNS)	The BNS challenges the U.S. to seek reductions in HCB releases from sources resulting from human activity by 2006. The BNS provides an established process for engaging stakeholders and seeking voluntary reduction efforts through an HCB Workgroup. The workgroup offers an opportunity for EPA to solicit and recognize efforts toward the virtual elimination of HCB in the Great Lakes. An additional challenge of the BNS is to assess atmospheric inputs of strategy substances to the Great Lakes and, if long-range sources are confirmed, to work within international frameworks to reduce releases of such substances.
EPA's Agency-wide Multimedia Strategy for Priority Persistent, Bioaccumulative, and Toxic (PBT) Pollutants	Building on the BNS, the PBT Strategy seeks to reduce risks from persistent toxic substances at a national level. The PBT Strategy targets HCB as a Level 1 pollutant. The aim of the PBT Strategy is to respond to the cross-media issues associated with PBT pollutants by going beyond the traditional single-statute approaches in order to reduce risks to human health and the environment from existing and future exposure to PBT pollutants. The PBT national action plan for HCB will seek to coordinate efforts among all EPA national and regional programs as well as to collaborate with international organizations to reduce risks from current and future exposure to HCB.
EPA's Integrated Urban Air Toxics Strategy	This strategy identifies 33 air toxics, including HCB, that present the greatest threat to public health in the largest number of urban areas. Building on its existing air toxics regulatory program, key components of the strategy are 1) regulations addressing sources at both the national and local level, 2) initiatives to identify and address specific community risks (e.g., though pilot projects), 3) air toxics assessments (including expanded air toxics monitoring and modeling) to identify areas of concern, to prioritize efforts to reduce risks, and to track progress, and 4) education and outreach efforts to inform stakeholders about the strategy and to seek input for program design and implementation.
EPA's Contaminated Sediment Management Strategy	EPA's Contaminated Sediment Management Strategy utilizes a cross-program policy framework to promote consideration and reduction of ecological and human health risks posed by sediment contamination. The strategy advocates cross-program coordination, as well as a watershed approach, to prevent and remediate existing sediment contamination and to prevent future contamination. Actions required to manage legacy contaminated sediment sites as well as sites with existing discharges, include source control, pollution prevention, and remediation.

Table 6. Current Domestic and International Efforts Targeting HCB (Continued)

Current Domestic and International Efforts Targeting HCB	
Program	**Description**
Lakewide Management Plans (LaMPs)	The U.S. and Canadian governments agreed to develop LaMPs for each of the five Great Lakes under Annex 2 of the 1987 Great Lakes Water Quality Agreement. The purpose of the LaMPs is to assess critical pollutants as they relate to the impairment of beneficial uses of the Great Lakes and to develop measures to restore beneficial uses where they have been impaired. HCB has been identified as a critical pollutant in the Lake Ontario and Lake Superior LaMPs, each of which is in a different stage with respect to its lakewide management plan. As part of the Lake Superior LaMP, a Binational Program to Restore and Protect the Lake Superior Basin was announced in 1991. One of the goals of this program is to achieve zero discharge and emissions of persistent toxic pollutants, including HCB, in the Lake Superior Basin.
Remedial Action Plans (RAPs)	The Great Lakes RAP program originated from a 1985 recommendation made by the International Joint Commission's Great Lakes Water Quality Board and was formalized in the 1987 amendments to the GLWQA. The aim of RAPs is to restore beneficial uses in 43 Areas of Concern (AOCs) identified in the Great Lakes Basin where beneficial uses or the area's ability to support aquatic life have been impaired. Through the RAP program, Canada and the U.S. are committed to cooperating with state and provincial governments to incorporate a systematic and comprehensive ecosystem approach to address critical pollutants, to restore beneficial uses, and to ensure that the public is consulted in all actions undertaken to develop and implement RAPs for designated AOCs. HCB is suspected of contributing to use impairments in some AOCs.
Pesticide Clean Sweeps	Pesticide Clean Sweeps are waste pesticide collection and disposal programs that provide a means of collecting and disposing of accumulated agricultural pesticides. Although pesticide uses for HCB were canceled in 1984 and remaining stocks were allowed to be used, data from Minnesota Clean Sweeps have indicated that unused stocks of HCB have recently been collected in that state.
Draft Pesticide Registration (PR) Notice	EPA has issued a draft Pesticide Registration (PR) Notice to manufacturers, producers, formulators and registrants of pesticides (USEPA, 1999). The notice provides guidance to the registrant for improving the clarity of labeling statements in order to avoid confusing directions and precautions and to prevent the misuse of pesticides. Improved product labeling statements are intended to clearly identify what is required of the user to handle and apply a pesticide safely. This may reduce HCB emissions and exposure through proper storage, transportation, handling, pre-application activities, mixing and loading, worker notification and worker protection, application, post-application activities and disposal.

Table 6. Current Domestic and International Efforts Targeting HCB (Continued)

Current Domestic and International Efforts Targeting HCB	
Program	**Description**
International Programs	
UN ECE Convention on Long-Range Transboundary Air Pollution (LRTAP) protocol	In February 1998, under the United Nations' Economic Commission for Europe Long Range Transboundary Air Pollution (LRTAP) Convention, 43 countries completed negotiations on a regional Persistent Organic Pollutants (POPs) protocol. The LRTAP Protocol sets a framework for controlling, reducing, and eliminating discharges, emissions, and losses of persistent organic pollutants, including HCB.
United Nations Environment Program (UNEP) Persistent Organic Pollutant (POP)	The U.S. and member countries are currently working toward the development and signing of an international legally binding agreement on the control and reduction of persistent organic pollutants (POPs), including HCB, through UNEP POPs negotiations. As the agreement currently stands, member countries will be required to identify and quantify emission sources for all listed POPs, develop action plans for reduction, and make information available to the general public.
North American Agreement on Environmental Cooperation Sound Management of Chemicals Program	The Working Group of the Sound Management of Chemicals Program has approved HCB as a candidate substance for the development of a North American Regional Action Plan. The North American Working Group on the Sound Management of Chemicals was called for in Council Resolution #95-5, developed under the authority of the North American Agreement on Environmental Cooperation (NAAEC). Consistent with Council Resolution #95-5, the duties of the Working Group involve establishing how the Governments of Canada, Mexico, and the United States will cooperate to improve the sound management of chemicals in North America, giving priority to the management and control of substances of mutual concern that are persistent, bioaccumulative and toxic, but also allowing for cooperation on a broader scale for the sound management of chemicals in the three countries.
Arctic Monitoring and Assessment Programme (AMAP)	HCB is recognized as one of the POPs in need of greater monitoring and control in the Arctic under the Arctic Monitoring and Assessment Programme (AMAP). AMAP was established in 1991 to implement components of the Arctic Environmental Protection Strategy (AEPS) adopted by eight Arctic countries including the United States. In support of AMAP recommendations to assess health impacts of POPs and heavy metals in the Arctic, EPA and the National Center for Environmental Health are jointly funding a project to monitor selected heavy metals and POPs, including HCB, in umbilical cord blood and maternal blood of indigenous groups in the Arctic.

Table 6. Current Domestic and International Efforts Targeting HCB (Continued)

Current Domestic and International Efforts Targeting HCB	
Program	**Description**
Monitoring Efforts	
Integrated Atmospheric Deposition Network (IADN)	IADN is a joint monitoring network established by the U.S. and Canada in response to the Great Lakes Water Quality Agreement to address issues concerning airborne contaminants in the shared Great Lakes basin. IADN is designed to assess the magnitude and trends of atmospheric deposition of toxic substances to the Great Lakes and, where possible, to determine sources of atmospheric pollutants. Among other toxic chemicals, IADN currently monitors the atmospheric deposition of HCB.
CAA §112(m) program, Atmospheric Deposition to Great Lakes and Coastal Waters (Great Waters Program)	The 1990 Amendments to the CAA include Section 112(m), Atmospheric Deposition to Great Lakes and Coastal Waters, to establish research, reporting, and potential regulatory requirements related to atmospheric deposition of hazardous air pollutants (HAPs) to the "Great Waters". EPA's Great Waters Program coordinates activities to address the requirements of Section 112(m). HCB is one of 15 Great Waters pollutants of concern. The "Great Waters" referred to in this program are the Great Lakes, Lake Champlain, Chesapeake Bay, and specific coastal waters designated through the National Estuary Program and the National Estuarine Research Reserve System. EPA provides biennial Great Waters Reports to Congress discussing the current scientific understanding of atmospheric deposition and the health and environmental effects of toxic pollution, as well as EPA programs to protect human health and the environment.
USEPA National Study of Chemical Residues in Fish	Study design and peer review of EPA's National Study of Chemical Residues in Fish have been completed. EPA will statistically evaluate the incidence and severity of HCB and other chemical residues in fish, both downstream from suspected problem areas and in background areas. EPA will work with State Departments of Health and Environmental Protection and will coordinate with state fish advisory programs. Sampling will begin in fiscal year 1999 (FY99) and conclude in Summer 2001. Study results will be available in FY02.
National Health and Nutrition Examination Surveys (NHANES)	Conducted by the Centers for Disease Control and Prevention's (CDC's) National Center for Health Statistics, the National Health and Nutrition Examination Surveys (NHANES) traces the health and nutritional status of U.S. civilians. Human exposure to HCB will be measured and tracked in NHANES 1999.
National Oceanic and Atmospheric Administration (NOAA) Mussel Watch Program	The National Oceanic and Atmospheric Administration's (NOAA) Mussel Watch Project has been using measurements of contaminants in mussel and oyster tissues since 1986 to evaluate the status and trends in contaminant levels in the nation's Great Lakes, estuarine, and marine waters. Sites are visited approximately biennially for collection of animals to be analyzed for a suite of over 70 contaminants, including HCB.

Current Domestic and International Efforts Targeting HCB	
Program	**Description**
FDA Pesticide Residue Monitoring Program (Total Diet Study)	HCB is analyzed in the Food and Drug Administration's (FDA) pesticide residue monitoring program. To enforce pesticide tolerances set by EPA for imported foods and domestically produced foods shipped in interstate commerce, the FDA acquires incidence/level data on commodity/pesticide combinations and carries out its market basket survey, the Total Diet Study. FDA also samples and analyzes domestic and imported animal feeds for pesticide residues. Results of FDA's Total Diet Studies are available in published reports and on FDA's Internet web site. HCB is among the pesticides found by methods used in the 1998 regulatory monitoring program (http:\\www.cfsan.fda.gov).

Other efforts that affect emissions of HCB include campaigns at state and local levels, voluntary industry initiatives, and changes in industry practices. Some examples include:

- Community programs to use alternatives to pesticides and to reduce the use of medical waste incinerators have been initiated in the Lake Superior Basin (WLSSD, 1998).
- Significant improvements in the manufacturing process for chlorothalonil (a pesticide) to reduce the content of HCB significantly.
- Recommendations of best management practices in Ontario to reduce emissions from the use of pentachlorophenol (containing HCB) in the wood preservation industry.
- The decision by two major utility companies in Ontario to eliminate the use of PCP in the treatment of utility poles, thereby reducing HCB emissions from wood preservation (Benazon, 1999).
- A commitment by Dow Chemical Company to reduce air and water emissions of mercury and HCB by 75 percent by 2005.

6.0 CONCLUSIONS

Status of Knowledge Concerning Sources

Due to long-range transport and atmospheric deposition of HCB, sources of HCB releases transcend the boundaries of the Great Lakes Basin. Sources in closest proximity to the Great Lakes, such as the application of pesticides in and around the Great Lakes, likely have the greatest impact on HCB loadings within the basin. However, there is evidence that sources far from the basin also contribute to HCB loadings in the basin, though more research on long-range transport modeling of HCB is needed to gain a better understanding of this loadings pathway.

The relative significance of HCB sources to the Great Lakes Basin is uncertain. Table 7 summarizes the current status of sources of HCB in the U.S. Data show that, for 1990, the highest emissions in the U.S. result from chlorinated solvents production, pesticides manufacture, tire manufacture, cyclic crude and intermediate production, chemical manufacture of alkalies and chlorine, and pesticide application. More recent data from the tire manufacturing industry suggest that emissions from this sector are lower than previous estimations. Due to the scarcity of major industrial sources of HCB within the basin, emissions from pesticide application may be a dominant source of HCB to the Great Lakes Basin, with lesser contributions from industrial sources outside the basin. Releases from residual sources for which emission estimates are not available are also thought to contribute to HCB contamination in the basin. These include releases from waste incineration and cement kilns, open trash burning, PCP-treated utility poles, and sewage treatment plants.

Several chemical reporting mechanisms show that HCB continues to be released to the environment. Air and water releases from pesticide and chemical manufacturing facilities have been reported to TRI as recently as 1997, and these were reported with relatively high reporting threshold requirements. The proposed lower reporting threshold requirements for 2000 may generate a greater number of HCB releases being reported to TRI. HCB appears in various waste streams reported to RCRA's Biennial Reporting System, particularly the wastes from industrial chlorination processes. Releases of HCB from residual sources go unreported.

Although decreasing trends have been demonstrated for HCB levels in environmental media of the Great Lakes over the last 10-20 years, the region remains an area of particularly high contamination for fish and wildlife. HCB concentrations in mussels from the Great Lakes were found to be more than five times higher than HCB levels in mussels from coastal waters of the U.S. (Robertson and Lauenstein, 1998). Monitoring data from IADN stations in the Great Lakes indicate that the net movement of HCB involves volatilization out of the water. Soils and sediments at several sites in the Great Lakes Basin are also contaminated with HCB.

Table 7. Summary of Current Status of Sources of HCB in the U.S.

Source Category	Status
Chlorinated Solvents Production	< SOCMI HON (40 CFR 63.100) rule will control organic HAP emissions < Voluntary initiatives are being pursued through BNS
Pesticides Manufacture	< 1997 TRI emissions: 5 lbs to air, 26 lbs to water < A recently finalized PAI rule will control HAP emissions < Voluntary initiatives are being pursued through BNS
Pesticide Application	< Reduced HCB content in chlorothalonil will lower emissions < Alternative pest management programs discourage the use of chemical pesticides
Tire Manufacturing	< Industry expected to report zero emissions as a result of recent testing
Cyclic Crude and Intermediate Production	< 1997 TRI emissions: 14 lbs to air < One manufacturing facility reported releases to TRI
Chemical Manufacturing: Alkalies and Chlorine	< 1997 TRI emissions: 135 lbs to air, 250 lbs to water, 139 lbs injected underground < Dow Chemical, a major chemical manufacturer, has committed to reduce HCB emissions by 75% by 2005
Miscellaneous Organic Chemicals Production (MON - Continuous Processes)	< Miscellaneous Organic NESHAP (MON) limits emissions
Chemicals and Allied Products Manufacturing	< Category may be included in Chemical Manufacturing: Alkalies and Chlorine category
Hydrochloric Acid Production	< Current emissions unknown
Utility Coal Combustion	< Not included in most recent emissions inventory
Aluminum Degassing	< Emissions from the use of HCE may be a concern at some small secondary aluminum furnaces
Waste Incineration and Cement Kilns	< Emissions expected to be reduced by MACT standards
Open Barrel Trash Burning	< Current emissions unknown < May be a concern in rural townships and tribal communities
Wood Preservation	< Current emissions unknown < Ontario measures to lower emissions include implementing best management practices and reducing the use of PCP to treat utility poles
Sewage Treatment Plants	< Current emissions unknown < HCB-contaminated ferric chloride may contribute to the problem

Regulations and Regulatory Gaps

Regulations are in place to control emissions from chlorinated solvents production and pesticides manufacture, the two largest sources of national HCB emissions. Voluntary initiatives in the pesticides industry have been shown to result in additional reductions of HCB in chlorothalonil, a commonly used pesticide. Similar voluntary efforts might prove successful in lowering levels of HCB in other pesticides and in chlorinated solvents.

HCB emissions from other major source categories might also be reduced by voluntary efforts, rather than through regulatory controls. For example, enhanced efforts to control or re-route air emissions or effluent discharges from cyclic crude and intermediate production might result in reduced release to the environment. Community programs encouraging the use of alternatives to HCB-containing pesticides may help reduce HCB emissions from pesticide application.

Actions and regulations have been promulgated to control emissions of toxic pollutants from waste incineration and cement kilns. Although HCB is not a targeted pollutant, emissions of HCB will likely be reduced as a result. For example, actions have been undertaken to reduce mercury and dioxin emissions from medical waste incinerators by reducing the volume and toxicity of waste incinerated. New regulations require controls on medical waste incinerators, municipal waste combustors, cement kilns and lightweight aggregate kilns to limit organic chemical and metals emissions. Because these actions and regulations are intended to reduce organic emissions overall, reductions in HCB emissions are expected.

HCB emissions from residual sources are variously controlled. Statutes banning open trash burning exist for some states and municipalities, but it is difficult to enforce these statutes. There may be a need for increased regulations and enforcement or for increased education and recycling opportunities. PCP containing HCB is used to treat utility poles. Whether methods exist to contain HCB emissions from PCP spills and releases during wood treatment is not known. Also, there are no restrictions on the use of old utility poles and railroad ties treated with PCP for residential purposes. Sewage treatment plants may take measures to determine the source of HCB discharges to their facility, and NESHAPs for sewage sludge incinerators may control HCB emissions. However, there are no limitations on the content of HCB in ferric chloride used in waste water treatment.

Although water and waste regulations are in place, release to these media still occurs. Hazardous wastes generated by chlorination processes are regulated under RCRA and are subject to pre-treatment standards prior to landfill disposal. However, there is the potential for HCB to leach from contaminated landfills. Water releases are regulated under the NPDES permit system, but TRI reports indicate that HCB has been discharged for the past several years from industrial facilities in the alkalies and chlorine and agricultural chemical sectors.

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APPENDIX A

Appendix A contains information on HCB releases available from several federal and state reporting systems. Federal and state agencies collect information on HCB releases as part of broader programs designed to meet reporting requirements for multiple substances. It is important to keep in mind that each data set must be interpreted separately due to differences in reporting requirements and the types of information collected. Where information is available, data are organized by Standard Industrial Classification codes (SIC codes). This structure offers a uniform method to identify industrial sectors. The first two digits of an SIC code identify major industrial sectors. The full four digit code allows more specific identification of industry type. Even with this detailed breakdown, variation exists within a given SIC code. For a complete list and description of SIC codes, as well as the specific industrial processes covered by each code, refer to the Standard Industrial Classification Manual.

Table A1. Trends in HCB Releases from 1990 to 1997 by SIC Code from TRI

SIC Code	1990	1991	1992	1993	1994	1995	1996	1997
Air Fugitive or Non-Point Emissions								
2800	2	88	42	–	–	–	–	–
2812	347	192	3,852	48	64	216	96	106
2865	829	21	4	0	12	15	14	14
2879	80	248	240	247	247	246	5	5
2869	–	0	0	9	0	0	0	0
3241	–	–	–	–	23	–	–	0
Air Stack or Point Air Emissions								
2800	100	120	1	–	–	–	–	–
2812	102	160	332	331	112	89	105	29
2865	1	1	0	0	0	0	0	0
2879	7	11	0	0	0	0	0	0
2869	–	0	0	1	0	0	0	0
3241	–	–	–	–	0	–	–	0
Disposal								
2800	4	–	5	–	–	–	–	–
2812	7	7	1	7	–	–	8	6
2869	–	–	–	250	–	–	–	–
2879	33,981	1,064,786	28,374	647,753	940,476	6,975	23,441	12,032

Table A1. Trends in HCB Releases from 1990 to 1997 by SIC Code from TRI (Continued)

SIC Code	1990	1991	1992	1993	1994	1995	1996	1997
Land Releases								
2800	0	0	0	–	–	–	–	–
2812	0	1	0	0	0	0	0	0
2865	0	0	0	0	0	0	0	0
2869	–	0	0	0	0	0	0	0
2879	0	1	0	0	0	0	0	0
3241	–	–	–	–	–	–	–	0
Underground Injection								
2800	0	0	0	–	–	–	–	–
2812	220	60	794	548	204	480	–	–
2865	0	0	0	0	0	0	–	–
2879	0	0	0	0	0	0	–	–
2869	–	0	0	0	0	0	–	–
3241	–	–	–	–	0	–	–	–
Water Releases								
2800	9	1	32	–	–	–	–	–
2812	92	98	190	390	248	6,344	250	250
2865	0	0	0	0	0	0	0	0
2869	–	0	0	80	0	0	0	0
2879	23	12	5	6	21	114	24	26
3241	–	–	–	–	0	–	–	0

Table A2. HCB Concentration Data from IADN Master Stations 1992-1994 Annual Averages

Year	Superior			Michigan			Huron			Erie			Ontario		
	Precip (ng/L)	Particle (pg/m³)	Gas (pg/m³)	Precip (ng/L)	Particle (pg/m³)	Gas (pg/m³)	Precip (ng/L)	Particle (pg/m³)	Gas (pg/m³)	Precip (ng/L)	Particle (pg/m³)	Gas (pg/m³)	Precip (ng/L)	Particle (pg/m³)	Gas (pg/m³)
1992	0.10	0.20	98.0	0.06	0.10	120	0.13	NA	0.05	0.04	0.20	80.0	0.30	0.10	130
1993	0.37	3.91	68.0	0.25	3.56	87.4	0.18	NA	31.1	0.15	4.18	102	0.11	NA	33.8
1994	0.10	0.20	70.2	0.06	0.10	77.5	0.08	NA	28.2	0.04	0.20	83.5	0.04	NA	43.3

Table A3. Summary of HCB Reporting Data in Great Lakes States

Reporting System[1]	Number of Facilities Reporting								
	Total	IL	IN	MI	MN	NY	OH	PA	WI
BRS	69	5	7	11	2	5	29	9	1
PCS	60	14	2	4	1	0	7	0	32
TRI	0	0	0	0	0	0	0	0	0

[1] Data is the most current available for each reporting system:
Biennial Reporting System (BRS): 1995
Permit Compliance System (PCS): 1995-1999
Toxic Chemical Release Inventory (TRI): 1997

Table A4. Sites Within EPA Region 5 Currently on the Final NPL (Superfund) with HCB Detected as a Contaminant of Concern

	Site Name	City	State
1	Woodstock Municipal Landfill	Woodstock	Illinois
2	American Chemical Service, Inc.	Griffith	Indiana
3	Reilly Tar & Chemical (Indianapolis Plant)	Indianapolis	Indiana
4	Metamora Landfill	Metamora	Michigan
5	Ott/Story/Cordova Chemical Co.	Dalton Township	Michigan
6	Rasmussen's Dump	Green Oak Township	Michigan
7	Thermo-chem, Inc.	Muskegon	Michigan
8	Chem-dyne	Hamilton	Ohio
9	Fields Brook	Ashtabula	Ohio
10	Skinner Landfill	West Chester	Ohio
11	Summit National	Deerfield Township	Ohio